ZooKeys 1205: 191–204 (2024)
DOI: 10.3897/zookeys.1205.117807

Research Article

An updated review of the genus *Toxorhina* Loew, 1850 (Diptera, Limoniidae) from Yunnan, China with a description of a new species

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Abstract

Seven species of the genus *Toxorhina* Loew, 1850 have been recorded from China, of which three are known to occur in Yunnan Province. Herein, all known species from Yunnan, China are reviewed with more detailed descriptions and illustrations of the male hypopygium. A species of *Toxorhina* belonging to the subgenus *Ceratocheilus* Wesché, 1910 from Yunnan, *T.* (*C.*) *pianmica* **sp. nov.**, is described and illustrated as new to science.

Key words: *Ceratocheilus*, crane flies, Elephantomyiini, Limoniinae, male hypopygia, taxonomy

OPEN ACCESS

Academic editor: Pavel Starkevic
Received: 25 December 2023
Accepted: 15 April 2024
Published: 24 June 2024

ZooBank: https://zoobank.org/31CA30DA-E778-4046-B479-5F1705D4FC9A

Citation: Lv H, Xu Y, Liu S, Li L, Lin K, Zhang X (2024) An updated review of the genus *Toxorhina* Loew, 1850 (Diptera, Limoniidae) from Yunnan, China with a description of a new species. ZooKeys 1205: 191–204. https://doi.org/10.3897/zookeys.1205.117807

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Introduction

Toxorhina Loew, 1850 is a genus in the family Limoniidae (Diptera) with 152 extant species and subspecies, of which 79 species and two subspecies belong to the subgenus *Ceratocheilus* Wesché, 1910, 68 species belong to the subgenus *Toxorhina* and three species belong to the subgenus *Eutoxorhina* Alexander, 1934 (Oosterbroek 2023). Members of *Toxorhina* differ from most limoniid crane flies in their particularly elongate rostrum and are often recorded as feeding on flowers (e.g., Alexander and McAtee 1920; Alexander 1937; Lehnebach and Robertson 2004; Oosterbroek and Lukashevich 2021). The genera *Elephantomyia* Osten Sacken, 1860 and *Helius* Lepeletier & Serville, 1828 (in Latreille et al. 1828) have a similar elongate rostrum to *Toxorhina*, and these three genera, together with another limoniid genus without an elongate rostrum (i.e., *Protohelius* Alexander, 1928), form the tribe Elephantomyiini (Alexander 1920; Savchenko et al. 1992; Hynes 1997; Podenas and Gelhaus 2007; Kang et al. 2023).

Seven species of *Toxorhina* have been recorded from China, of which four (three new species and one newly-recorded species) were published in Zhang et al. (2015), in which all Chinese species were revised. After that, we

had the opportunity to examine more specimens of Elephantomyiini collected from Yunnan Province, China, deposited in the Entomological Museum of China Agricultural University, Beijing, China (CAU). Yunnan is a part of the Yunnan-Guizhou Plateau and has a diverse environment and high species diversity; three species of *Toxorhina* are known to occur in the province (Zhang et al. 2015; Oosterbroek 2023). In this study, we obtain more specimens for all three known species of *Toxorhina* in Yunnan and provide more detailed descriptions and illustrations of the male hypopygium. In addition, a new species of *Toxorhina* from Yunnan, *T.* (*C.*) *pianmica* sp. nov., is also described and illustrated.

Material and methods

The specimens of this study were collected through light trapping at different locations in Yunnan, China (Fig. 1) and deposited in the CAU. Preparations of the male hypopygium were made by soaking dissected tip of abdomen in cold 10% hydroxide (NaOH) for 10 hours. Details of body coloration were examined in specimens immersed in 75% ethanol (C_2H_5OH). Prepared specimens were examined using a ZEISS Stemi 2000-C stereomicroscope. Photographs were captured using a Canon EOS 5D Mark IV digital camera through a Canon EF100 mm f/2.8L Macro IS USM lens, and the details of the male hypopygium were captured by that camera attached to a Phenix PH100-3B41L-IPL biomicroscope.

The morphological terminology mainly follows Cumming and Wood (2017) and de Jong (2017). The following abbreviations in figures are used: **aed** = aedeagus, **ea** = ejaculatory apodeme, **goncx** = gonocoxite, **gonst** = gonostylus, **i gonst** = inner gonostylus, **interb** = interbase, **o gonst** = outer gonostylus, **pm** = paramere, **st** = sternite, **tg** = tergite.

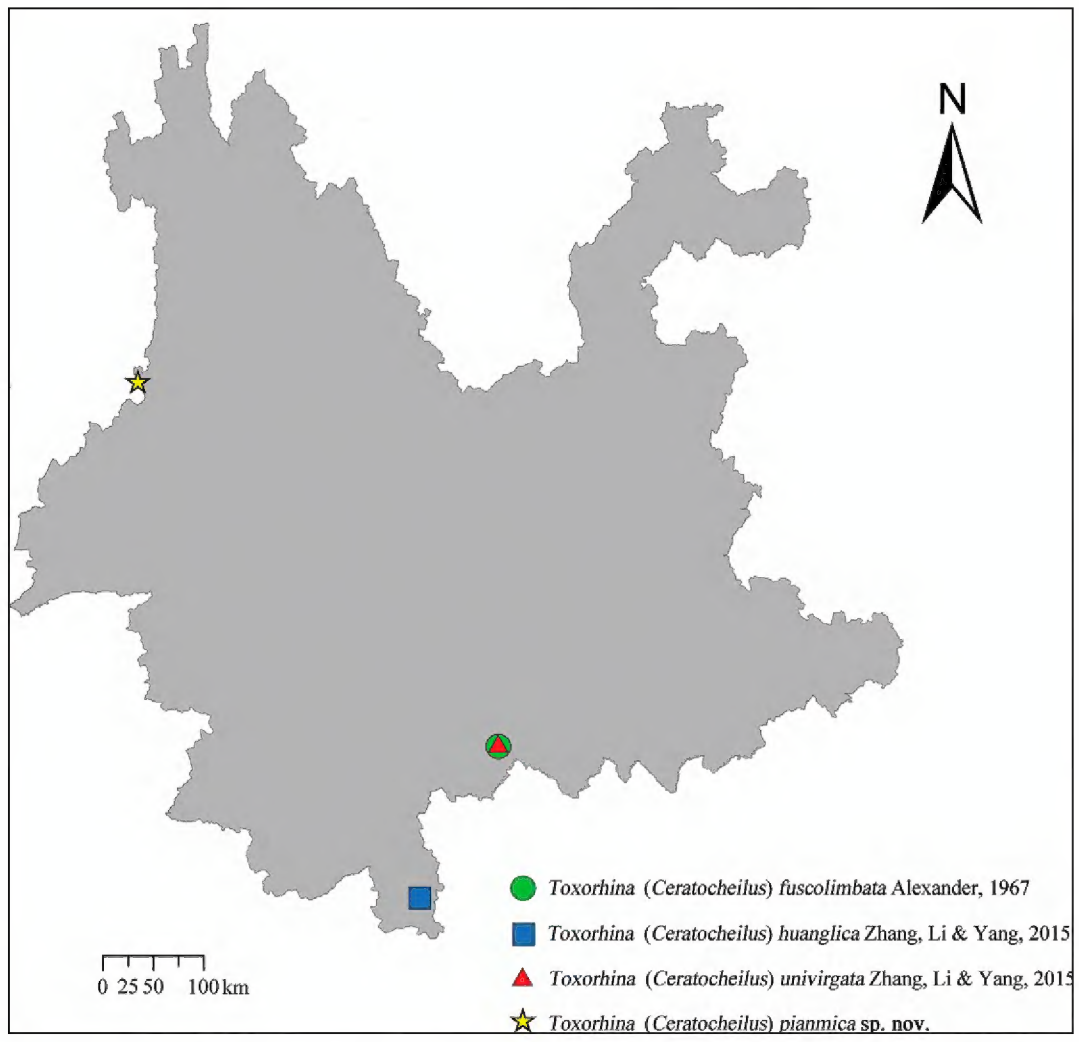

Figure 1. Collecting sites of *Toxorhina* species from Yunnan, China in this study. *Toxorhina* (*Ceratocheilus*) *fuscolimbata* and *T.* (*C.*) *univirgata*, Huanglianshan National Nature Reserve; *T.* (*C.*) *huanglica*, Xishuangbanna Tropical Rainforest Nature Reserve; *T.* (*C.*) *pianmica*, Pianma Town.

Taxonomy

Key to species of the genus *Toxorhina* from Yunnan

1 Wing with black seams along cord and m-m (Zhang et al. 2015: fig. 3d). Gonocoxite with 2 gonostyli (Fig. 2A, B) ..... ***Toxorhina* (*Ceratocheilus*) *fuscolimbata* Alexander, 1967**

– Wing without conspicuous seams along cord or m-m (Figs 4D, 6B, C; Zhang et al. 2015: figs 5d, 13d). Gonocoxite with 1 gonostylus (Figs 3A, B, 5A, B, 7A, B) **2**

2 Pleuron without longitudinal stripe (Fig. 4A). Wing with cell d open by absence of m-m, R_4 ending slightly before end of basal section of R_5 (Fig. 4D). Gonocoxite dorsally with three brownish-black, stout preapical setae (Fig. 5A, F) ..... ***Toxorhina* (*Ceratocheilus*) *pianmica* sp. nov.**

– Pleuron with one or two longitudinal stripes (Fig. 6A; Zhang et al. 2015: figs 3a, 5a, 13a). Wing with cell d closed, R_4 ending beyond r-m (Fig. 6B, C; Zhang et al. 2015: figs 3d, 5d, 13d). Gonocoxite dorsally without stout preapical setae (Figs 2A, 3A, 7A) **3**

3 Pleuron dark yellow with two black longitudinal stripes (Zhang et al. 2015: fig. 5a). Wing with R_4 ending slightly beyond end of basal section of R_5 (Zhang et al. 2015: fig. 5d). Gonocoxite dorsally with a blunt, basal lobe; lobe provided with numerous stout setae (Fig. 3A, G). Interbase elongated, rod-shaped, about 10 times as long as wide (Fig. 3A, B, C, E). Tip of aedeagus bifid with arms short (Fig. 3A, B, C, E, I) ..... ***Toxorhina* (*Ceratocheilus*) *huanglica* Zhang, Li & Yang, 2015**

– Pleuron yellow with one dark brown longitudinal stripe (Fig. 6A; Zhang et al. 2015: fig. 13a). Wing with R_4 ending beyond end of basal section of R_5 by 1/3–2/5 of its own length (Fig. 6B, C; Zhang et al. 2015: fig. 13d). Gonocoxite dorsally without basal lobe (Fig. 7A). Interbase as a short and flattened plate, about 3 times as long as wide (Fig. 7A–D). Tip of aedeagus bifid, arms very long, filiform (Fig. 7A–D, H) ..... ***Toxorhina* (*Ceratocheilus*) *univirgata* Zhang, Li & Yang, 2015**

Toxorhina (*Ceratocheilus*) *fuscolimbata* Alexander, 1967

Fig. 2

Toxorhina (*Ceratocheilus*) *fuscolimbata* Alexander, 1967 in Alexander 1967: 185. Type locality: India, Assam, Manipur, Hkayam Boum.
Toxorhina (*Ceratocheilus*) *fuscolimbata* in Zhang et al. 2015: 64.

Specimens examined. China • 2 ♂♂; Yunnan Province, Lvchun County, Huanglianshan National Nature Reserve, Yakou Protection Station; 1931 m a.s.l.; 22.8956°N, 102.3008°E; 7 July 2016; Qilemoge leg.; light trap; CAU.

Diagnosis. Prescutum and presutural scutum brownish-yellow with three broad and nearly confluent brownish-black longitudinal stripes. Pleuron yellow with two black longitudinal stripes. Wing with black seams along cord and m-m and paler seam over base of CuA. Cell d closed. R_4 ending beyond end of basal section of R_5 by half of its own length, m-cu beyond fork of M by 1/4–1/2 of its own length. Gonocoxite with 2 gonostyli. Gonocoxite dorsally without stout

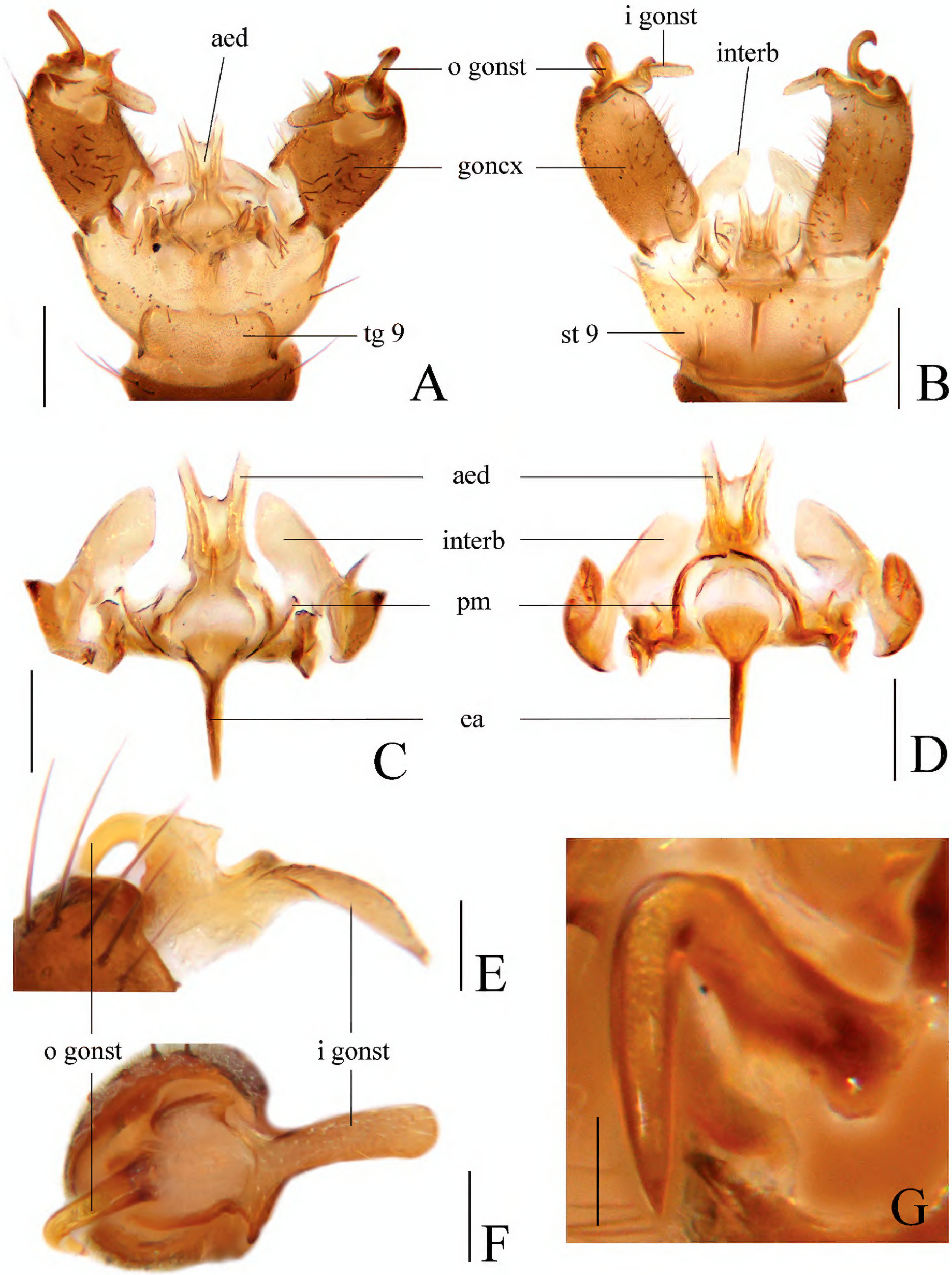

Figure 2. *Toxorhina* (*Ceratocheilus*) *fuscolimbata* **A** male hypopygium, dorsal view **B** male hypopygium, ventral view **C** aedeagal complex, dorsal view **D** aedeagal complex, ventral view **E** gonostyli, dorsal view **F** gonostyli, posterior view **G** outer gonostylus, posterior view. Scale bars: 0.2 mm (**A, B**); 0.1 mm (**C, D**); 0.05 mm (**E, F**); 0.02 mm (**G**).

preapical setae. Interbase as a short and flattened plate. Tip of aedeagus bifid with arms short and divergent.

Description. Male. Hypopygium (Fig. 2). Tergite 9 brownish-yellow with dark brown setae, posterior margin with a broad and nearly rounded emargination (Fig. 2A). Gonocoxite dark brown, cylindrical, with dark brown setae; setae on dorsal side darker and stronger (Fig. 2A, B). Outer gonostylus dark brown, slender and rod-shaped, about 10 times as long as wide, strongly curved ventrally and inwards at middle; tip acute (Fig. 2A, B, E–G). Inner gonostylus brownish-yellow, about 4 times as long as wide, with rounded tip, basally provided with additional, ventral horn-like process (Fig. 2A, B, E, F). Interbase brownish-yellow, as a short and flattened plate, about 3 times as long as wide; tip blunt (Fig. 2A–D). Parameres dark brown, arched and medially fused, distally connecting to base of interbase (Fig. 2C, D). Ejaculatory apodeme dark brown, rod-shaped and straight, about 7 times as long as wide (Fig. 2C, D). Aedeagus brownish-yellow, stout at base, tip bifid with arms short and divergent (Fig. 2A–D).

Distribution. China (Guangxi, Tibet, Yunnan), India (Oosterbroek 2023).

Behavior. The species can be attracted by light.

Remarks. Alexander (1967) first described this species based on one male and two female specimens collected in India, and later added figures of the wing and male hypopygium for this species (Alexander 1970). Zhang et al. (2015) reported this species as a new record from China and redescribed and illustrated it. A more detailed description and illustration of the male hypopygium of this species are provided in this study.

Toxorhina (*Ceratocheilus*) *huanglica* Zhang, Li & Yang, 2015

Fig. 3

Toxorhina (*Ceratocheilus*) *huanglica* Zhang, Li & Yang, 2015 in Zhang et al. 2015: 67. Type locality: China, Yunnan, Lvchun, Huanglianshan, Qimaba.

Specimens examined. China • 1 ♂; Yunnan Province, Mengla County, Xishuangbanna Tropical Rainforest Nature Reserve, Wangtianshu Scenic Spot; 661 m a.s.l.; 21.5090°N, 101.6003°E; 9 July 2016; Qingxia Zhou leg.; light trap; CAU.

Diagnosis. Prescutum and presutural scutum brownish-yellow with three broad dark brown longitudinal stripes. Pleuron dark yellow with two black longitudinal stripes. Wing with cell d closed. R_4 ending slightly beyond end of basal section of R_5, m-cu at or slightly before fork of M. Gonocoxite with 1 gonostylus. Gonocoxite dorsally with a blunt, basal lobe covered with numerous setae. Interbase elongated, rod-shaped. Tip of aedeagus bifid with arms short and divergent.

Description. Male. Hypopygium (Fig. 3). Tergite 9 brown with dark brown setae, posterior margin medially with U-shaped deep incision and two translucent areas on both sides (Fig. 3A, F). Gonocoxite dark brown, conical with tip round; dorsal face with a blunt, basal lobe covered with numerous stout setae (Fig. 3A, G); setae on gonocoxite brownish-black (Fig. 3A, B). Gonostylus brown, curved inwards at middle, basal half stout with a longitudinal groove, distal half slender with tip round; outer side of middle with outwardly curved spine (Fig. 3A, B, H). Interbase dark brown, elongated, rod-shaped, about

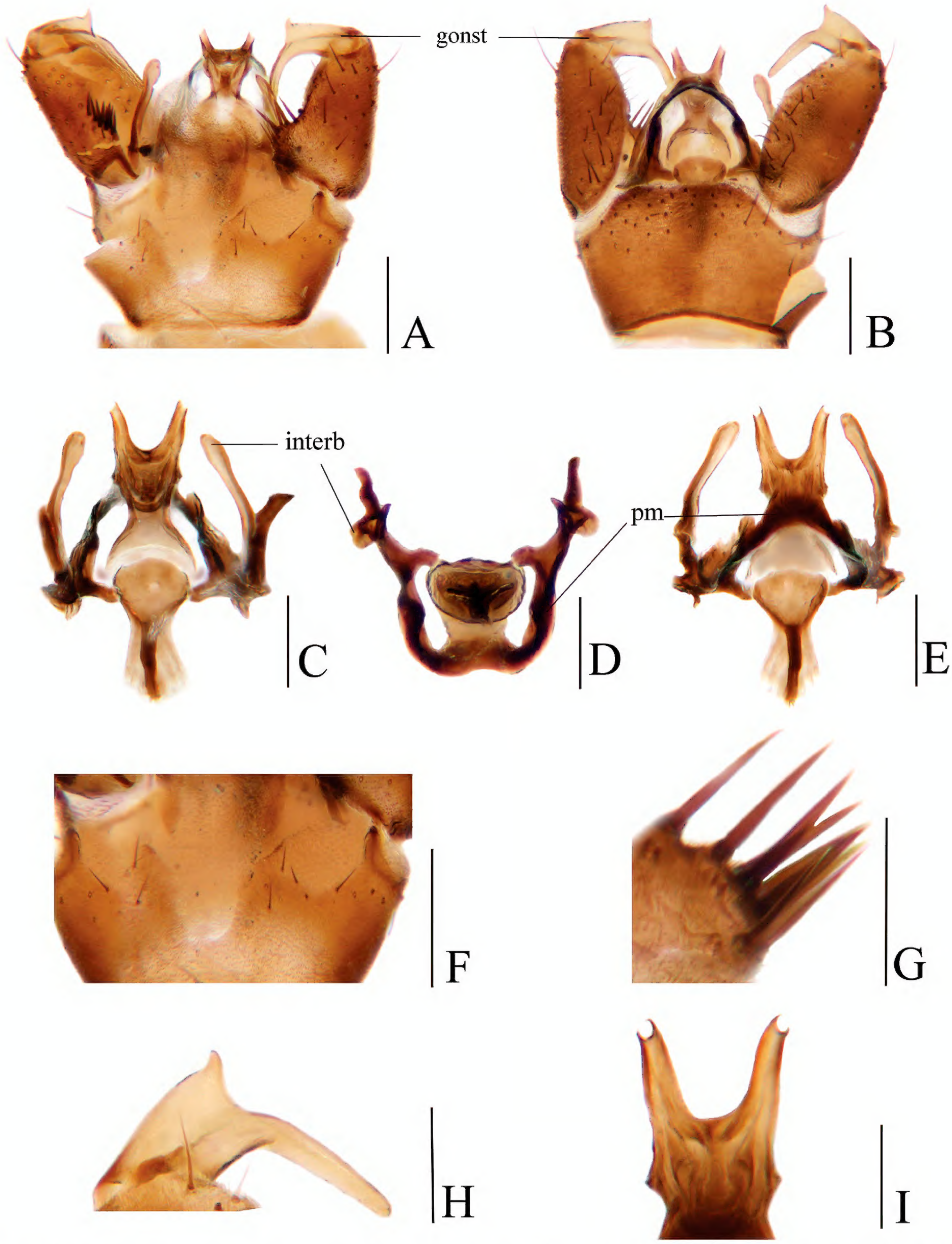

Figure 3. *Toxorhina* (*Ceratocheilus*) *huanglica* **A** male hypopygium, dorsal view **B** male hypopygium, ventral view **C** aedeagal complex, dorsal view **D** aedeagal complex, posterior view **E** aedeagal complex, ventral view **F** posterior margin of tergite 9, dorsal view **G** setae at base of gonocoxite, dorsal view **H** gonostylus, dorsal view **I** tip of aedeagus, ventral view. Scale bars: 0.2 mm (**A, B**); 0.1 mm (**C–F, H**); 0.05 mm (**G, I**).

10 times as long as wide; tip inflated and round (Fig. 3A–C, E). Parameres brownish-black, medially arched fused, distal connecting to base of interbase (Fig. 3C–E). Ejaculatory apodeme brown with middle brownish-black, sheet-like, base narrow (Fig. 3C–E). Aedeagus dark brown, stout at base, tip bifid with arms short and divergent (Fig. 3A–C, E, I).

Distribution. China (Yunnan) (Oosterbroek 2023).

Behavior. The species can be attracted by light.

Remarks. The species was originally described and illustrated by Zhang et al. (2015) based on material collected in China. A more detailed description and illustration of the male hypopygium of this species are provided in this study.

***Toxorhina* (*Ceratocheilus*) *pianmica* Xu, Lv & Zhang, sp. nov.**
https://zoobank.org/C4EF4120-18B3-44FF-8398-0745D97927D3
Figs 4, 5

Type material. ***Holotype.*** CHINA • ♂; Yunnan Province, Lushui County, Pianma Town; 2123 m a.s.l.; 26.0142°N, 98.6272°E; 6 July 2013; Xuankun Li leg.; light trap; CAU. ***Paratypes***. CHINA • 3 ♂♂; same data as for holotype; CAU.

Diagnosis. Prescutum and presutural scutum dark brown with edges of prescutal suture and both sides of caudal edge darker (Fig. 4C). Pleuron dark brown. Wing with cell d open by absence of m-m. R_4 ending slightly before end of basal section of R_5, m-cu before fork of M by about 1/3 of its own length. Gonocoxite with 1 gonostylus. Gonocoxite dorsally with three brownish-black, stout preapical setae, and a blunt lobe at inside of base; the lobe with nine stout setae. Interbase elongated, rod-shaped. Tip of aedeagus bifid with arms short and divergent.

Description. Male (Fig. 4A). Body length 4.4–4.9 mm (excluding rostrum), wing length 4.5–5.0 mm, rostrum length 2.7–3.0 mm, halter length 0.6–0.7 mm.

Head (Fig. 4B). Dark brown. Setae on head dark brown. Antenna with scape pale brown, pedicel and first flagellomere brown, remaining flagellomeres pale brown. Scape short cylindrical, with dark brown setae. Pedicel globular, with dark brown setae. First flagellomere oval, remaining flagellomeres cylindrical; terminal two flagellomeres longest with pale brown verticils. Rostrum about 3/5 of length of wing, brown with dark brown setae.

Thorax (Fig. 4C). Pronotum brown. Prescutum and presutural scutum dark brown, with edges of prescutal suture and both sides of caudal edge darker. Postsutural scutum dark brown, paler in middle area. Scutellum dark brown with side and caudal edges black, paler in middle area. Mediotergite brown with side edges brownish-black. Pleuron dark brown (Fig. 4A). Coxae yellow with bases brown; trochanters yellow; femora brown with bases paler; tibiae brown; base of fore tarsus brown, remaining tarsi missing. Setae on legs brown. Wing (Fig. 4D) pale brown, without stigma. Veins brown. Venation: Sc ending slightly beyond origin of Rs; sc-r a great distance before tip of Sc; R_4 ending slightly before end of basal section of R_5; distal section of R_5 approach M_{1+2} toward tip; CuP curved suddenly at middle; cell d open by absence of m-m; m-cu before fork of M by about 1/3 its own length. Halter yellow.

Abdomen (Fig. 4A). Segments 1–6 brown with caudal edges darker, segments 7–8 dark brown.

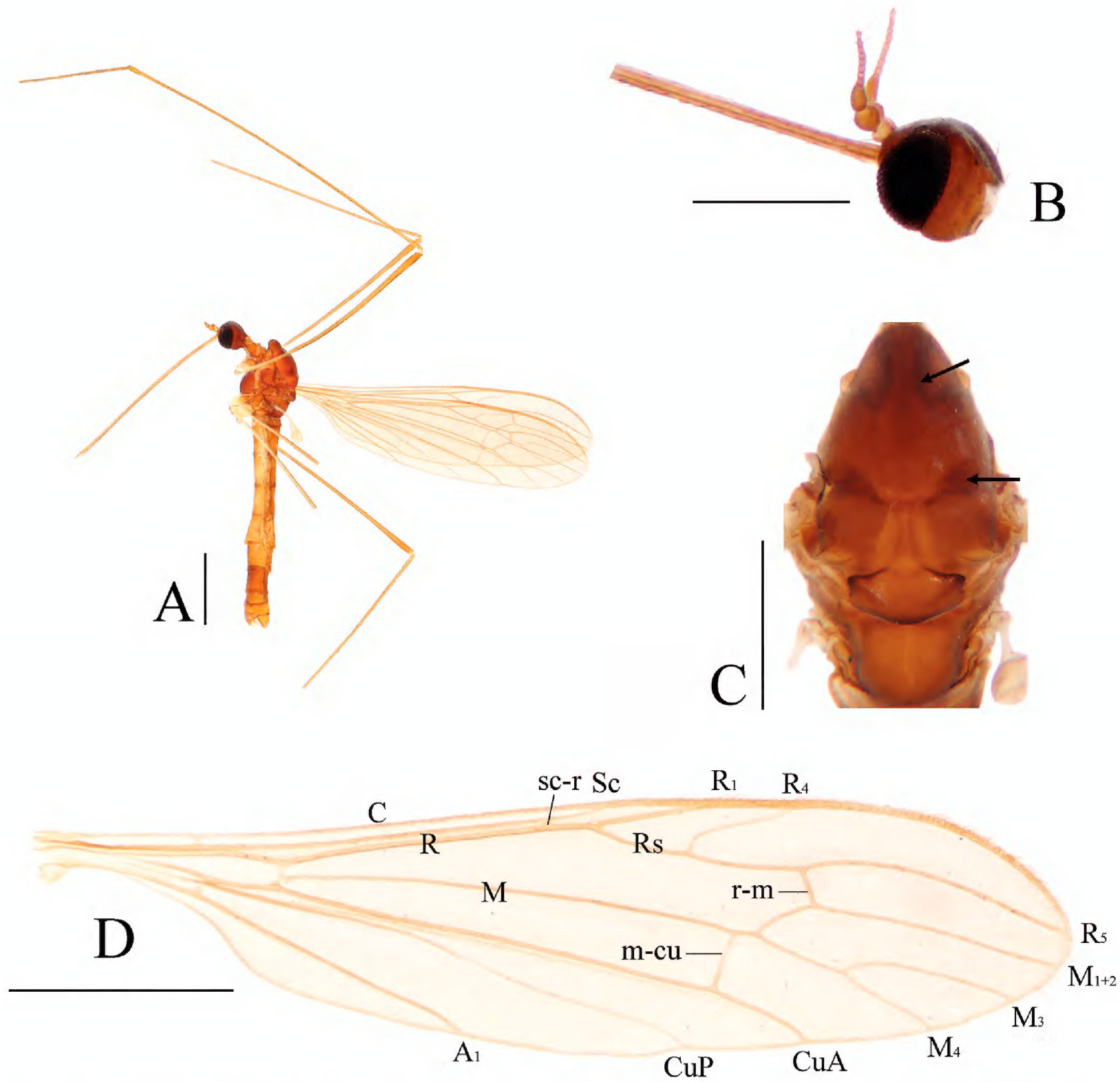

Figure 4. *Toxorhina* (*Ceratocheilus*) *pianmica* sp. nov. **A** habitus of male, lateral view **B** head, lateral view **C** thorax, dorsal view (the arrows refer to the dark areas on prescutum and presutural scutum) **D** wing. Scale bars: 1.0 mm (**A, D**); 0.5 mm (**B, C**).

Hypopygium (Fig. 5). Tergite 9 dark brown with dark brown setae, posterior margin with two large translucent areas on both sides (Fig. 5A, E). Gonocoxite brown, conical with tip round (Fig. 5A, B); dorsal face with a few sparse brown setae at outside, three brownish-black, stout preapical setae (Fig. 5A, F), and a blunt lobe at inside of base, this lobe with nine stout setae (Fig. 5A, G); ventral face with numerous brown setae at inside (Fig. 5B). Gonostylus brownish-yellow, curved inwards at basal 1/3; the basal 1/3 stout with a longitudinal groove, distal 2/3 slender with tip round; outer side of basal 1/3 with outwardly curved spine (Fig. 5A, B, H). Interbase pale brownish-yellow, elongated, rod-shaped, about 10 times as long as wide; tip inflated and round (Fig. 5A–D). Parameres dark brown, medially arched fused, distally connecting to base of interbase (Fig. 5C, D). Ejaculatory apodeme dark brown except pale base, rod-shaped (Fig. 5C, D). Aedeagus dark brown, stout at base, tip bifid with arms short and divergent (Fig. 5A–D, I).

Female. Unknown.

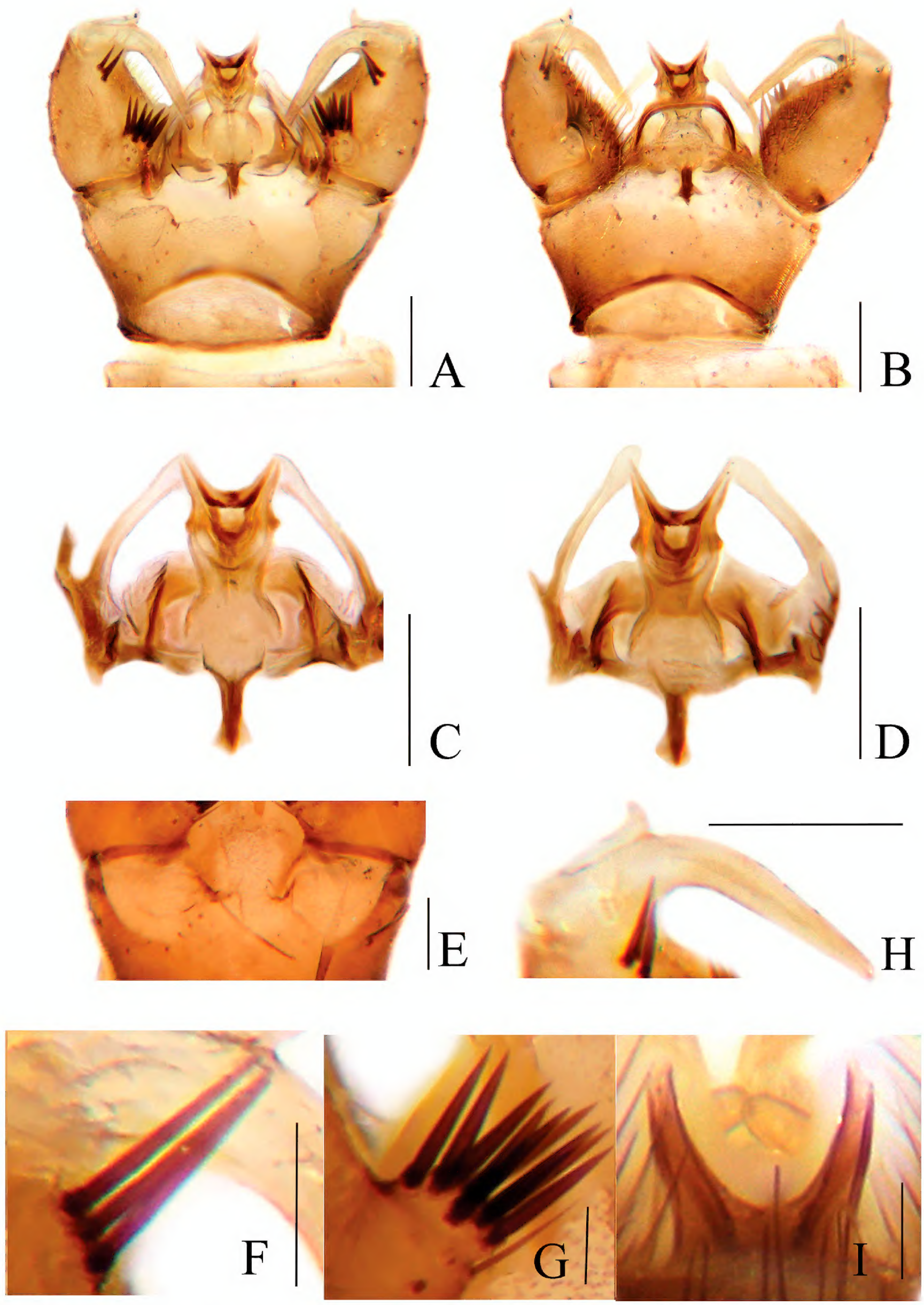

Figure 5. *Toxorhina* (*Ceratocheilus*) *pianmica* sp. nov. **A** male hypopygium, dorsal view **B** male hypopygium, ventral view **C** aedeagal complex, dorsal view **D** aedeagal complex, ventral view **E** posterior margin of tergite 9, dorsal view **F** preapical setae gonocoxite, dorsal view **G** setae at base of gonocoxite, dorsal view **H** gonostylus, dorsal view **I** tip of aedeagus, ventral view. Scale bars: 0.1 mm (**A–E, H**); 0.02 mm (**F, G, I**).

Etymology. The species is named after the type locality, Pianma Town.

Distribution. China (Yunnan).

Behavior. The species can be attracted by light.

Remarks. The new species is similar to *T.* (*C.*) *simplicistyla* Alexander, 1967 from India in having similar wing venation, but can be separated by the brown abdomen with segments 7–8 darker (Fig. 4A), the gonostylus conspicuously curved with a spine at the basal 1/3 (Fig. 5A, B, H), and the interbase with the tip inflated (Fig. 5A–D). In *T.* (*C.*) *simplicistyla*, the abdomen is brownish-black, the gonostylus is very gently curved with a spine near the middle, and the tip of the interbase is not inflated (Alexander 1967).

***Toxorhina* (*Ceratocheilus*) *univirgata* Zhang, Li & Yang, 2015**

Figs 6, 7

Toxorhina (*Ceratocheilus*) *univirgata* Zhang, Li & Yang, 2015 in Zhang et al. 2015: 76. Type locality: China, Yunnan, Lvchun, Huanglianshan.

Specimens examined. China • 4 ♂♂; Yunnan Province, Lvchun County, Huanglianshan National Nature Reserve, Yakou Protection Station; 1931 m a.s.l.; 22.8956°N, 102.3008°E; 7 July 2016; Qilemoge leg.; light trap; CAU.

Diagnosis. Prescutum and presutural scutum brownish-yellow with three broad brown longitudinal stripes. Pleuron yellow with one dark brown longitudinal stripe. Wing with cell d closed. R_4 ending beyond end of basal section of R_5 by 1/3–2/5 of its own length, m-cu from a distance before to at fork of M. Gonocoxite with 1 gonostylus. Gonocoxite dorsally without stout setae. Interbase as a short and flattened plate. Tip of aedeagus bifid with arms very long.

Description. Male (Fig. 6A). Body length 5.3–5.8 mm (excluding rostrum), wing length 5.0–5.5 mm, rostrum length 4.8–5.3 mm, halter length 0.6–0.7 mm.

Head (Fig. 6A). Rostrum slightly shorter than wing, dark brown with dark brown setae.

Thorax (Fig. 6A). Coxae pale yellow, fore coxa slightly darker; trochanters yellow with tips black; femora brown with bases paler; tibiae brown; tarsi brown with tips slightly paler (Fig. 6A). Wing with position of m-cu unstable, ranging from a distance before fork of M to at fork of M (Fig. 6B, C).

Hypopygium (Fig. 7). Tergite 9 brownish-yellow with dark brown setae, posterior margin with two nearly triangular lobes, separated by V-shaped incision, laterally with two translucent areas on both sides (Fig. 7A, E). Gonocoxite brownish-yellow, long conical with tip round; setae on gonocoxite dark brown, outside of ventral face without setae (Fig. 7A, B). Gonostylus brown with distal half paler, curved inwards at middle, basal half stout with numerous small spines at outer side, distal half slender with tip round; outer side of middle with a spine; the spine curved outwards (Fig. 7A, B, F, G). Interbase brownish-yellow, as a short and flattened plate, about 3 times as long as wide; tip blunt (Fig. 7A–D). Parameres pale brownish-yellow with edges brown, sheet-like, distally connecting to base of interbase (Fig. 7C,

Figure 6. *Toxorhina* (*Ceratocheilus*) *univirgata* **A** habitus of male, lateral view **B** wing **C** variation of wing (the arrow refers to the positional variation of m-cu). Scale bars: 2.0 mm (**A**); 1.0 mm (**B, C**).

D). Ejaculatory apodeme pale brownish-yellow with middle brown, sheet-like, base narrow (Fig. 7C, D). Aedeagus pale brownish-yellow with brown, stout base; tip bifid, arms filiform and very long, bent dorsally with tip bent outward (Fig. 7A–D, H–J).

Distribution. China (Yunnan) (Oosterbroek 2023).

Behavior. The species can be attracted by light.

Remarks. Zhang et al. (2015) described and illustrated this species as a new species from China. This study supplements the description of the legs, wing, and rostrum. In addition, a more detailed description and illustrations of the male hypopygium of this species are also provided.

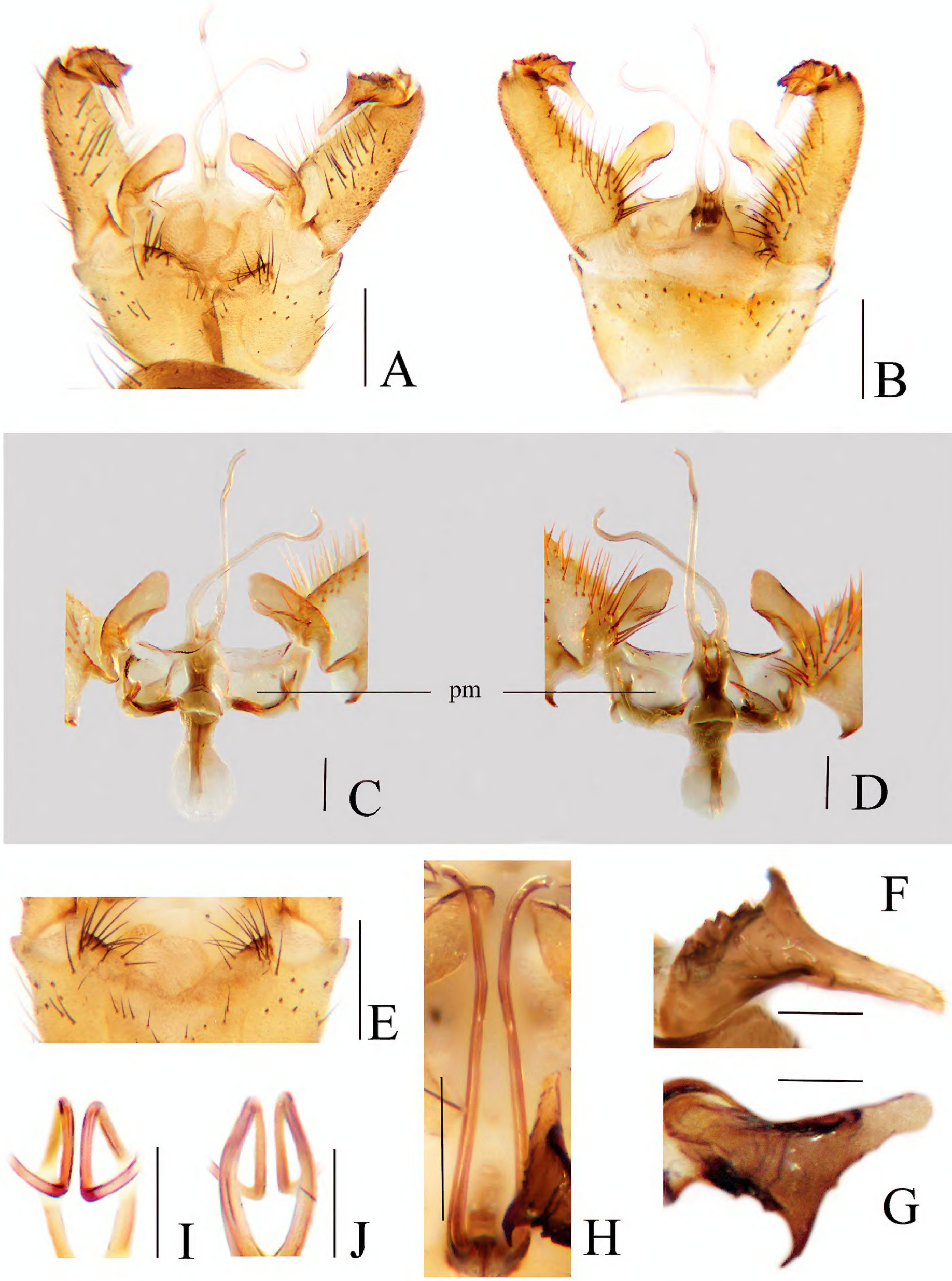

Figure 7. *Toxorhina* (*Ceratocheilus*) *univirgata* **A** male hypopygium, dorsal view **B** male hypopygium, ventral view **C** aedeagal complex, dorsal view **D** aedeagal complex, ventral view **E** posterior margin of tergite 9, dorsal view **F** gonostylus, dorsal view **G** gonostylus, posterior view **H** aedeagus, posterior view **I** tip of aedeagus, dorsal view **J** tip of aedeagus, ventral view. Scale bars: 0.2 mm (**A, B, E**); 0.1 mm (**C, D, H–J**); 0.05 mm (**F, G**).

Acknowledgements

We express our sincere thanks to Ding Yang for his great help during the study of specimens from the CAU. We are also very grateful to Xuankun Li, Qilemoge and Qingxia Zhou for collecting the specimens.

Additional information

Conflict of interest

The authors have declared that no competing interests exist.

Ethical statement

No ethical statement was reported.

Funding

This work was supported by the National Natural Science Foundation of China (32100356), the National Science & Technology Fundamental Resources Investigation Program of China (Grant No. 2019FY100400) and the National Animal Collection Resource Center, China.

Author contributions

Conceptualization, X.Z. and K.L.; methodology, X.Z.; resources, X.Z.; data collection, S.L. and L.L.; taxonomic study, H.L., Y.X. and X.Z.; writing–original draft preparation, H.L., Y.X., S.L. and L.L.; writing–review and editing, X.Z. and K.L.; visualization, H.L., Y.X., S.L. and L.L.; supervision, X.Z. and K.L.; project administration, X.Z. and K.L; funding acquisition, X.Z. and K.L.

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Data availability

All of the data that support the findings of this study are available in the main text.

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